Food Grows Where Water Flows:
Agriculture and Drought in Southern Wisconsin

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Abstract

Since the 1930s, the farming industry of southern Wisconsin has endured many droughts. New farming practices, market structures, and government policies have been implemented to combat the effects of drought in the area. In our research we have found which of these have worked, which have not, and what needs to be done in the future to maintain a stable and lucrative farming industry in southern Wisconsin. By collecting historical data through archives, past reports, and historical photographs, we have compared the effects of past droughts to those of modern times. The years of focus have been the droughts of the 1930's, 1988, and 2012. We conducted interviews and surveys at present time to understand how the effects of current droughts compared to those of past droughts. We have concluded that advances in practice, policy, and market structure have maintained a stable and thriving economy in the region. Yet, the future hold much uncertainty as to how drought should be dealt with in the future when the country as a whole has been met with economic crisis. The debate rages on.

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1. Introduction

Agricultural farmland in Stoughton, Wisconsin, piqued the interest of the group and became the landscape for this project. Many different factors can change a landscape. Drought is the main factor we will concentrate on in this project. The research questions to answer are the following: How has drought shaped changes in farming practices, market structures, and governmental policies since the 1930's? and What are farmer's perspectives on such measure today?. We have chosen a short timescale starting with the 1930's because a major drought hit the United States otherwise known as the Dust Bowl. The major droughts picked for discussion are the 1930's drought, the 1988 drought, and the 2012 drought in order to collect data from surveys and interviews with farmers living through the timescale or part of the timescale.

Answers to the research question will come from an abundance of primary data sources. To help us define drought and also help find years of major drought from the 1930s to the present, we will use the Palmer Drought Severity Index. Aerial photographs recreate the scene of the landscape over the past 70 years. Looking at the aerial photographs will help determine the effect of drought on the landscape. Along with the aerial photographs, Plat Books and Land Ownership Maps will help see the effect drought had on farmers. On these maps it will show if more farmers sell their land after a drought season. Discussions with the long-time agricultural farmers of the area will provide us another primary data source. We will use relief maps to find the topography of Stoughton. In addition, we will compare and contrast pictures of the landscape from the past and the present to see what has changed. With each picture we will try to have the same point of view to show variation or the lack thereof. Another aspect of our research will be to looking into archival records for articles, pictures, diaries, and other useful information for answering the research question.

Our plan to answer the question is possessed in a multiple step process. First is to conduct a literature review of appropriate book chapters and articles that pertain to our research question. Next is to search through years in the Palmer Drought Severity Index to choose the years chosen for the project. Then, look at the aerial photographs, Plat books, and Land Ownership Maps to compare farmland with ownership. Also, taking a look at relief maps to better inform the type of topography dealt with in these farmlands. Next is to formulate questions for the farmers to answer for interviews and surveys that relate to drought of 2012, droughts of the past, basic information of the farm, governmental policy, market structures, and the other information about the land. After we have received the information from the farmers, we will look for archival articles pertaining to similar experiences or events mentioned in our interviews. Finally, we will pull all of the information together and look at the data as a whole, drawing appropriate conclusions from the collected data.

Projects will be divided up equally be all of the group members. All members of the group will examine articles and book chapters for equal division of the literature review. Michael will look into the Palmer Drought Severity Index to find the extreme droughts and he will also research Plat Books. Shasta will look into the archival records for pictures and other data. Jon is researching the aerial photographs. Surveys will be distributed by all of the group members. Michael will set up the interviews with the farmers. All group members will conduct interviews since we feel it is important that we all be there to get the full amount of information from the interviews.

2. Literature Review

Our research question asks how drought has shaped changes in farming practices, market structures, and government policies since the 1930s. Also, we are asking what the farmer's perspectives on drought are today. Theories of the landscape explain why the landscape is important and what drought can change in our physical landscape. Drought, the physical landscape, and the drought policy in the United States are all key concepts that are important to our research. The Palmer Drought Severity Index, interviews, newspapers, journals, photographs, and archival sources are some of the techniques that will be explored to answer our research question. Major droughts occurred in the 1930s, the 1980s, and also in 2012. The landscape that our research is concentrated on is Stoughton, WI and surrounding areas in southern WI (Map 1).

Landscape can be seen as a whole that should be looked at equally between all fields of science and art in order to study the entire landscape. In "The Integrity of the Landscape Movement," in Understanding Ordinary Landscapes, Jay Appleton uses the chapter to serve as a warning to the integrity of the landscape movement. The landscape movement is a coming together of diverse minds trained in different disciplines (Appleton 1997: 189). This theory of how to view a landscape is important in how to approach answering our research question. Looking at the landscape of Stoughton, WI from multiple perspectives in both physical and human geography will allow us to effectively study the effects of major droughts that have occurred over the past century. All fields of research should communicate and complement one another in the research in order to prevent the research from being swayed too much into one field of the research. It is not always necessary to have a visual reference in order to study a landscape. Historical documents can recreate a vision of the landscape that cannot be captured by photographs or paintings (Appleton 1997: 189-199). In our research, we will be looking at

historical documents to try and visualize what droughts were like in the past. In "Changing Technology, Values, and Rural Landscapes," in Wisconsin Land and Life, Ostergen and Vale describe both the human and physical ingredients on different landscapes in Wisconsin. What are the processes that changed landscape throughout the history of Wisconsin is what they are asking. Mechanization and hybridization of the landscape are described in order to show how large scale agriculture can be accomplished by no longer doing work by hand. Technology has allowed human activities to increasingly modify the natural world through farming advances (Ostergren 1997: 354). The quality of this data provides accurate observations on how farming practices have changed from the 1920s through the 1970s. Good farming practices are important during times of drought to minimize the damage caused by the drought.

How drought is managed on the farm is a concept that is important to our research. "Drought Management on Farmland", by Joan Whitmore, provides in depth detail on present drought management. Everything from a basic understanding of plant interactions with drought conditions, soil management, and irrigation systems are covered in Whitmore's book. Some of the questions that are addressed in this book include: What gets planted under what conditions and why? How do farmers maintain soil moisture in drought conditions? How does one assess the risk of drought on ones farm? The entire book will be beneficial to answering our research question, not just one chapter. Some theories to cope with drought that are explained are to maintain soils through drought, plant crops best suited for the current conditions, and proactive measures are the best solutions during drought (Whitmore 2000). For our research, being knowledgeable about how drought is prepared for will allow us to ask more insightful questions while distributing surveys and conducting interviews.

Not far from Stoughton, WI, "The Wisconsin Dust Bowl" in Wisconsin Magazine of History: Volume 73, Number 3, Spring 1990, by Michael Goc, focuses on seventeen towns in the middle of Wisconsin. Goc uses tables to represent changes that occurred in population from 1930 to 1950 as well as percentage of sand in the soils at the time, which was close to one hundred percent (Goc 1990: 162-201). How farmers survived throughout the drought is also important. In our research, we will also be looking at the effect of drought on dairy farms. An important method that Goc describes to maintain throughout the drought of the 1930s was to abandon dairy farming. The emergency seed program allowed farmers of Wisconsin to access many of the seeds the government had bought in order to combat surplus. Planting trees to fight erosion also helped in maintaining the soils. Data backs up the concepts and theories of mismanagement of crops, mismanagement of soils, importance of trees, and importance of relief programs (Goc 1990: 162-201). Goc provides a historical narrative perspective in order to shed light on the issues during the 1930s in Wisconsin. Understanding droughts of the past is an important concept in comparing more recent droughts.

Agricultural problems and farmer relief will also be helpful in answering our research question. "6. Agricultural Problems and Relief" in The Dust Bowl: An Agricultural and Social History, by Douglas Hurt, provides a general understanding of the American Dust Bowl. Hurt produces the names of many agencies that gave economic relief, but does not go into much depth about the specifics of the various programs. The most significant aid during the Dust Bowl was from the Agricultural Adjustment Administration (AAA), created by congress in 1933. Hurt credits the AAA with giving the aid, but leaves many questions unanswered. Another agency is the Farm Security Administration (FSA), which provided loans to farmers with no other means to borrow from other sources (Hurt 1981). Hurt discusses the instability of the agricultural

market and the collapse in prices due to an overproduction of wheat. Concepts from this chapter also include economic fall due to crop mismanagement and regulation, and that the drought would have been much worse for farmers without aid from the government. Brought up by this chapter is the question was brought back to normalcy and how it might affect the market today is brought up by this chapter. In our research, these questions that come out this book chapter lead us to be asking the correct questions of how markets are structured during and after droughts. One of the more difficult questions to answer is shown by this chapter.

Realizing that drought is common throughout history is important to understanding how nature recovers from drought. Droughts also follow a pattern as to when they occur and how severe they are. In "2000 Years of Drought Variability in the Central United States," in Bulletin of the American Meteorological Society, by Woodhouse, physical, economical, social, and political consequences by drought are explained. Droughts impact surface and groundwater resources and can lead to reductions in water supply, crop failure, diminishing power generation, and suspended recreation activities (Woodhouse 1998: 2,693). Severity of drought across many different areas can be seen in this article. Some areas are more susceptible to droughts because of the combination of atmospheric conditions, precipitation climatology, and jet streams. The Great Plains are an area that meets this criteria and it was the area that was greatest impacted by the drought of the 1930s. Many different techniques are used to record droughts from as far back as the 13th century, such as: tree ring chronologies, lake sediment data, history records, and eolian data (Woodhouse 1998: 2,696-2,704). Some past droughts were discovered to last centuries. Comparing this to droughts of the 20th century show recent droughts have been moderately severe and lasted a comparatively short time. This article also implies that society could be reaching a time when a drought of dimension unprecedented could be the largest

disaster in the 20th century. For our research, this article's information serves as an analogy for the current drought and in showing how drought is one of the most damaging climate-related hazards to impact societies throughout history (Woodhouse 1998: 2,693).

Physical landscape also has an important role in the effects of drought on the landscape. Dane county has mostly sandstone, limestone, and dolomite in its bedrock (Ventura 1998: 1). In 1988, about 81% of the land area consisted of farmland. Most of the materials over the bedrock are either calcareous material or material brought by glaciers. Materials over the bedrock are usually around ten feet thick, but can be up to hundreds of feet thick around the Yahara River Valley (Ventura 1998: 1). Stoughton, WI sits right on top of the Yahara River Valley. A few inches of wind blown loess has been deposited over the bedrock and bedrock materials blown from the Mississippi and Wisconsin River Valley causing most of the soils in the glaciated parts of Dane County to be silt loams. Silt loams increase the erodability of the soil. Soils in this area used to be fertile. Our ancestors, at a time when wheat prices were at a high, planted wheat continuously for 20-30 years without any technological practices such as: manure spreading, summer fallowing, and crop rotations (Ventura 1998: 1). A soil survey done in in 1972 showed that almost 25% of the land area has eroded soils. Understanding the vulnerability of the soils in Stoughton, WI can lead us to predict how the soil will react during a drought. Also, knowing the composition of the soils helps us understand the ability to hold water and produce crops even during a drought.

Bedrock geology also influences springs in the area of southern Wisconsin. Iowa County is to the west of Stoughton and Waukesha County is to the east of Stoughton. In "Assessing the Vulnerability of Spring Systems to Groundwater Withdrawals in Southern Wisconsin," from Geoscience Wisconsin, by Swanson, Bradbury, and Hart, research was done to confirm the

accuracy of historical and regional spring data sets for those two locations around Stoughton. Methods of their research included taking temporal samples of water from springs and doing tests on the water. Means TDS, nitrate concentrations, concentration of ions, and pH tests were some of the tests done. 26 springs in Iowa County and 20 springs in Waukesha Country were researched. Although Stoughton is not included directly in their tests, water for the farmlands in Stoughton may still come from springs in the area. Aquifer properties can be used to assess vulnerability to springs to changes in land use or groundwater withdrawals (Swanson 2009: 1). How the land gets the water can influence how the land is used. During drought, water levels drop and it makes it difficult for farmers to get water to their crops. Topography, geology, and developmental pressures in an area all influence how the water is used (Swanson 2009: 2).

Importance of trees on the landscape has many different roles. One of these roles is in drought prevention. Appreciation for trees on the landscape can be seen in "In Favor of Trees," from In a Sense of Place, a Sense of Time, by J.B. Jackson. Here, trees are seen as historically significant in survival and building for society. During the time of the depression years, tree-planting programs led to the starting points of environmental movements. Planting of trees can also be seen as a contradiction in our society because at the same time we are planting, we are also deforesting. Views of trees changed in society when we started to plant them for beauty and symbolism rather than uses (Jackson 1994: 99). Throughout the United States, this can be seen in the park systems. Trees are still seen as useful in soil protection today. In a broader sense, other plants can be planted in order to prevent the effects of drought and to minimize soil erosion. Concentrating mostly on the relationship of humans and tress, this chapter can be helpful in our research in order to look at different aspects of the landscape in how people use natural resources to cope with droughts.

Next, government relief for farmers affected by drought did not really start to emerge until the late 19th century and early 20th century. The first drought disaster loans were made to farmers during wartime in 1918. It was not until Herbert Hoover's administration (1929-1933) that federal aid for droughts took off (Dyson 1988: 1-10). In "History of Federal Drought Relief Programs," from the Economic Research Service: Staff Reports, Dyson explains how drought relief did not start until the drought crisis had already begun. Now, legislation is taking a more pro-active approach. An appendix of legislation gives a chronological representation of some of the more significant acts made by congress to combat droughts. Dyson presents a table that begins in 1930 and follows drought legislation all the way until 1988. Also explained are the driving factors for drought legislation during different time periods (Dyson 1998: 1-10). Drought relief historical data will be extremely helpful with our project. Official reports offer a concise history of reactions from the government to drought throughout history.

Government policies changed throughout the past century along with changes in agriculture. "Milestones in U.S. Farming and Farm Policy," from Amber Waves, by Dimitri and Effland, details the changes in agriculture into five different time periods. Time series consist of the 1900s to 1930s, 1930s to 1945, 1945 to 1970, and 1970 to 2000. Events that break up these periods are the beginning of the century to the Great Depression, then to when World War II ended up until when the economic expansion started to diminish, and lastly up until when a new century starts. Supporting claims that agriculture changed during these time periods comes from the USDA, U.S. Census Bureau, Census of Agriculture, and the Census of Population. Part of the USDA comes from the ERA, which is the Economic Research Service. Some of the important polices during the 1930s were the Agricultural Adjustment Act of 1933 and also the Soil Conservation and Domestic Allotment Act of 1936. The USDA was responsible for looking

into the history of agriculture and the economy. High prices for agriculture and high export demands were common in the 1900s until 1930. From 1930-1945 was a time when the New Deal came to affect agriculture in the U.S. Expansion of machinery from 1945-1970 was also important. Foreign competitors were important in agriculture from 1970-2000 (Dimitri 2005: 10-11). A background of the history of agriculture is the focus for this article and it will be helpful to our research by guiding us where to look for different changes in policy and agriculture.

Taking a deeper look into the Agricultural Adjustment Act of 1933 shows how Franklin D. Roosevelt established the New Deal in order to help farmers. Farming took a large role in the economy during the 1930s and President Roosevelt needed to make sure that the farmers kept farming the land. The act helps stabilize commodity markets by raising prices and giving farmers incentives to keep farming (Kind 2001: 23). The Agricultural Adjustment Act of 1933 shows to be one of the more important agricultural acts to help cope with the drought of the 1930s. Some of the acts that are written in government today are still influenced by this act. In "Farm Bills and Farmers," from Region, Lotterman critiques the Agricultural Adjustment Act of 1933. Lotterman looks at how the act could have been different to improve farming. Whether or not the act was disastrous or seen as a salvation and whether it was looking at the long or short-term objectives are other points that this article examines. External forces affecting the acts by government can also overpower farm policy. In looking closely at the Agricultural Adjustment Act of 1933, different aspects of farm policies such as: causes, effects, purpose, and predicted outcomes can be seen. Ways that farm policies were created in the past will have an impact on how the landscape of agriculture in southern Wisconsin is shaped today.

Moving from the 1930s to the 1980s shows differences in how drought was dealt with in agriculture. New farm income decreased in the drought region and increased in non-drought regions during 1988. Average farms in the drought region survived by selling off inventories and taking advantage of higher commodity prices to redeem Civilian Conservation Corps (CCC) loans. Despite drought, farms in all areas of the country continued to improve their solvency position. Nine states affected by drought in the Northern Midwest and included Wisconsin. Seventy percent of disaster payments for crops and 40 percent of that for livestock feed were received by the nine states (Whittaker 1990: 1-12). Understanding how the farming financial market works during times of drought is important to our research. Now, farmers have much more aid available to them when comparing past droughts. Changes show that by receiving government aid, farm financial patterns hardly changed and farms in drought regions during 1988 showed a stable financial position. Use of government aid by farm also showed that growth and stability were maintained during the drought in 1988 (Whittaker 1990: 1-12). Information taken from this article will be helpful to our research by looking at how the drought of 2012 is being dealt with.

3. Methodologies

One of the methods for measuring drought across the United States is the Palmer Drought Severity Index (PDSI). Intensity, duration, and spatial extent are measured using the PDSI (Boken 2005). Using the PDSI in our study area will be useful in seeing the effects of the drought throughout all of the time periods we are studying. The Standard Precipitation Index was created to address some of the problems with the PDSI and it is used to supplement data from the PDSI. The U.S. Drought Monitor is located online and you can use this to create

different maps and charts for your target area. Text accompanies the U.S. Drought Monitor that describes current impacts, future threats, and possible improvements to be made. Proactive strategies are the best methods to combat the effects of drought. Monitoring systems help in understanding past droughts and could also predict the severity of future droughts. The U.S. is always experiencing some degree of drought somewhere and drought monitors help us understand where these droughts are occurring (Boken 2005). The PDSI goes from a scale of 4 to -4, with 4 being the wettest and -4 being the driest for soils. Normalizing the data is important in order to compare values (Skaggs 1975: 391). By using the PDSI, we will be able to see the impacts of drought on the environment for our research area. We will be able to produce a scale to how severe the droughts were during different time periods in southern Wisconsin.

As a guide to our research, The Craft of Research Third Edition, by Booth, will be a valuable resource. Booth explains how to receive secondary sources to find problems and to support evidence. Primary source is the best way to receive data. For organization, revising, planning, and conclusions to our research, this book will be used. Some of the suggestions from this book include: read less critically, read to understand, take shorthand notes, read important information twice, quoting, paraphrasing, and summarizing (Booth 2008: 84-96). Suggestions made can be used in any type of research and will be beneficial in how we evaluate the drought effects.

Another way of evaluating the landscape comes from looking at aerial photographs. "Aerial Representation and the Recovery of Landscape," in Recovering Landscape, by Charles Waldheim, describes how using aerial photographs as a tool of surveillance, control, and instrumentality can be used to show relationships between cultural and environmental processes. Past examples of visualizing the landscape came from landscape

paintings. Older techniques include using balloons to take photographs and just taking photographs from elevated positions on the landscape. Recovery of a landscape requires the landscape to be documented throughout time (Waldheim 1999: 121-139). Environmental change from drought can easily been seen from aerial photographs from changes in farmland to changes in the elevation of water sources. The Robinson Map Library has aerial photographs dating back to 1937 for the area of Stoughton, WI. Photographs are not taken every year, but many of the drought years are covered in the 1980s also. Comparing aerial photographs from times when the landscape was not in drought to times when there were droughts will be useful in our research. Using aerial photographs is a valuable way to visually see the impacts of drought as a whole on the landscape.

Aerial photographs show the landscape from the viewpoint of an airplane flying overhead that is shooting a camera straight down using black and white film. Aerial photographs show the roads, buildings, farms, trees, water, croplands and everything else that the landscape has to offer. Aerial photographs are useful for land use planning, environmental studies, advertisement, surveillance, and recording the changing history of a landscape. In 1987, the National Aerial Photography Program (NAPP) was created with the goal to coordinate aerial photographs taken by State and Federal agencies across the U.S. Standard altitude for taking aerial photographs since 1987 has been 20,000 feet above the terrain. This allows each photograph to cover about 32 square miles. The U.S. Geological Survey and the U.S. Department of Agriculture collected the aerial photographs. By making the photographs available to the public, they can be used by a variety of different users for multiple purposes.

Methods on retrieving most primary data for our research are through an interview and surveys. The interview is with two farmers and surveys given to producers at the two farmer's

markets. Interviews are intended to learn about the life of the participants through long conversations, while the surveys give a general overview of all participants (Gomez et. al. 2010: Chapter 12). The interviews gave more in depth answers on these farmer's perspectives on governmental policies, market structures, and farming practices just in Stoughton, WI. Surveys gave a view of southern Wisconsin and their perspectives on water supplies for drought and non-drought years and inputs on governmental impacts. Surveys and interviews will give us the main perspectives and concerns dealing with drought.

Different archival works bring primary sources to coordinate with the perspectives from the interviews and the surveys. Archival works include aerial photographs, photographs or bird's eye views, land records, and other works (Gomez et. al. 2010: Chapter 14). Using archival works will let the landscape speak for itself as cultural landscapes already have representations that embed in meaning (Gomez et. al. 2012: Chapter 14). These landscapes are only in that particular spot and are unique to the locals. The locals in return use these landscapes specifically to fit their needs from that specific area. This can lead to an understanding of the illustrations that the farmer's put into perspective.

Methods to represent the data received from the interviews and surveys will produce graphs and charts. A locator map will visually show the location of Stoughton, WI in Dane County and also the location of Stoughton in the state. Charts will visualize information from each of the questions asked in the survey. Maps and charts are powerful tools that help visually communicate the information to the readers (Gomez et. al. 2010: Chapter 16). Visuals can be used to symbolize information received, in order to process the information easier.

4. Results Overview

Results were taken from interviews, surveys, aerial photographs, plat maps, and personal photographs from Stoughton, WI and southern WI. Interviews were conducted on two larger agricultural farms in Stoughton, WI, to inform us on their views on drought. Surveys were conducted at the Dane County Farmers' Market in order to see how drought affects smaller-scale farms. Aerial photographs from drought and non-drought years were interpreted in order to see how the landscape has physically changed throughout the years. Personal photographs include a dam located in Stoughton, WI. Plat maps are taken from various years in order show the change in land ownership throughout years. By looking at all of the results together, the effect of drought on agriculture in Stoughton, WI can be assessed.

5. Interview Results

5.1 Background Information

The interview was conducted on Saturday, November 10, 2012, with two area farmers that live in Stoughton, WI. These two farmers live right next door to each other and both are fourth generation farmers. One of the farms was even founded by her great grandfather in 1914. The interview was held at a bakery on East Main Street in Stoughton. The bakery was picked out by both of the farmers as a common ground that both were comfortable with. The confidentiality agreement (Appendix 1) was handed out to them and their names will not be used. Farmer #1 and Farmer #2 will refer to the names of the two. These two farmers know and understand their land better than anyone. They have their own ideas and voluntarily answered our questions to give us a better understanding on their beliefs.

During the interview twelve questions main questions were asked to get their perspectives about governmental policy, drought, and insurance. To see a full set of the

interview questions refer to Appendix 2. Two other questions not specifically asked but answered are where do farmers in the Stoughton areas sell their crops to and what kind of soils do they have to deal with.

Both farms are mid-size farms for the area, meaning they have around 600 to 800 acres of land. It is hard to expand their land present day because land is expensive and surrounding their farms all the land is in use. These two would not go into too much detail about their farm because farmers seem to keep their production secret from one another. Each farmer grows corn, wheat, tobacco, and soybeans. Farmer #1 has 150 cows and 50 steers. Farmer #2 would not comment on the amount of cows that he has but adds that pigs were part of the farm.

5.2 Comparing 2012 and 1988 Droughts

Each farmer remembers the major drought happening in 1988. When comparing it to this year's drought the 80's drought was much worse. When we compared the 1988 drought to the 2012 drought using the Palmer Drought Severity Index, we found that the 1988 drought was not much more severe. The difference in opinion between the 2 drought years may have been caused but the rain happening to fall at the better times in the current drought and better farming practices which have been implemented in the last 20 years. Farmer #1 said that major droughts usually happen every 20 years. During this year's drought the rain came at the right times, for example pollination. There was an above average yield for a drought year but below average for a normal year. On this year's drought the timing of the planting was the most important factor. Also, what made this drought better than the 1988 was that there were more efficient farming practices to reduce the effect.

5.3 Farming Practices

Lately, Elwynn Taylor, a professor of agricultural meteorology at Iowa State University, predicts a drought every year. There is no actual way to predict droughts though. The farmers have to wait and see what happens and react to the weather that comes. Once the crops are in the ground you cannot change much. Advances in farming technologies have helped this year's drought be less severe. During the 1930's, at the time of the Dust Bowl, land overuse which lead to depletion of soil nutrients and great amounts of erosion lead to the soils unable to recover. Practices for the 2012 drought that made it less severe than droughts of the past were: reduced tillage, cover crops, planting different types of crops, grazing, hailage, more technology, and hybrid corn/ soybeans. Although hybrid crops do not do as well some years (like this one) in other years they thrive. Changing in farmer's viewpoints and open-pollinated corn feed especially this year changed the effects of the drought. Both farmers said they do mostly no till except Farmer #1 said 150 acres get plowed on their fields. Mainly farmers in the Stoughton area do no till just some of the older populations and more experienced farmers still plow their fields. Lastly, the farmers use fertilizers like manure, lime, and gypsum to give important nutrients to the soil like nitrogen, phosphorus, and calcium.

For most farmers in Stoughton, irrigation is too expensive to implement. This differs from our collected surveys from small-scale farmers. Irrigation is a popular way of coping with drought on small-scale farms in southern WI. Many of the larger scale farmers just rely on the rain to give their crops water. Wells are used along with rainwater in order to feed the livestock living on the farm. Also, on Farmer #2 land there are some wetlands that can help, but this year and in years of drought the water in these wetlands decreases.

The soil in the area is junky! The farmers use all the land that they have to plant crops. They plow right up to the fence lines or land boundaries in order to produce maximum profit.

They will use any type of soils to plant crops. Farmer #2 gave an example of an area of his land where heavy clay soil is at the bottom of the hill, while at the top of the hill is a really sandy soil. This is part of the reason why there are many variations in the amount of bushels taken from each acre. Farmer #2 is also able to plant on more land when it is drier because the marshes decrease causing more eland to be available. Since rain came at right time, some plants succeeded. Some acres got 209 bushel, 103 bushel, or even 9 bushels depending on the types of soils that the crops were gown in. The heat during this year's drought did not have as much effect on the crops as it did on milk production.

Milk production had a high loss especially during July 3 through July 13, which was some of the hottest days this summer. Milk production at Farmer #1's farm usually is around 12,000 pounds per day. During this week their milk production was barely making 8,000 pounds, which is about a 4,000-pound drop. Fans were put in Farmer #1 to try and cool down the cows and the cows were drinking more water. After this time there was a slow recovery from drought productions rate to normal production rate. To help with water resources Farmer #1 uses a plate cooler, which is an energy efficient way to bring water to the cows and cool down the cow's milk. The plate cooler runs cold water coming from the well through pipes surrounding the milk that is heading to the cooler in order to cool it down. As the milk cools down but heats up the water, the water is fed to the cows. Cows that drink warmer water than cooler water produce more milk.

5.4 Market Structures

Different size farms sell to a wide range of consumers. With both farmers having medium sized farms, neither sells their crops to ethanol companies. Medium to smaller size farms sell to companies and people. Both farmers sell their crops to the Landmark Co-op in

Evansville, while other farmers known to the interviewees sell crops at farmer's markets or a local produce store. The larger farms usually around 2,000 to 3,000 acres will sell to ethanol plants like ones in Jefferson, WI or Middleton, WI because these companies prefer larger farms. The prices that these companies purchase depend on the type of year it was.

Market prices seem to be better during drought years because the demand is still high while the supply has lowered. Many crops are bought and sold before the harvest even begins. So, there are salesmen who buy and sell crops that are not even accounted for yet. This actually drives up the prices when the yield is lower than expected. Comparing this to the 1930's, the prices fell because farmers continued to produce a surplus of products, which caused record low farm income. During this time farm families took up a third of the population (Lotterman 1996: 4-14). This year corn prices were high, $7.00 to $8.00, a few weeks before the interview corn was over $8.00 a bushel. Corn usually will not go below $7.20 a bushel because of the demand. There are too many players in the market selling and buying that do not have it yet.

There was frustration when the subject of the Farm Bill came into discussion. Both of these farmers believe that it gives farmers a voice. The Farm Bill also allows them to protect themselves. Without the Farm Bill they do not have any representation in the government. With the exception of the Farm Bill that is still in Congress, both thought the government does a good job for the most part. From our survey results, this attitude toward the government for doing a good job tends to differ. One aspect of the farm bill that will affect dairy farmers is the MILC program. This reimburses farmer when milk prices drop below $10.00 per 100 pounds. This program may or may not be included in the New Farm Bill, but Farmer #1 does not believe that the price of milk will go below $10.00.

5.5 Government Policies

Many governmental policies came into effect during the 1930's. President Franklin D. Roosevelt implemented the New Deal in 1933. Some of the major programs that were created are the AAA, CCC, and the FCIC. Even though some of the programs still are used today, some were deemed unconstitutional. The government is involved with the market and with farmers through the policies. Some small-scale farmers that took the survey think the government controls too much to the point where the government intrudes. Others that took the surveys and both participants in the interview thought the government steps in just enough to give the farmers a voice.

One program that the government has implemented in order to help farmers is crop insurance. The FCIC or the Federal Crop Insurance Corporation was created on February 16, 1938 (USDA, 2012). Neither of the farmers applies for crop insurance for all their crops every year. Farmer #1 pays for crop insurance every year on one crop. This crop is tobacco and the reason they pay for insurance is because it is a high yield crop. The farmers have options when choosing the right crop insurance. Even though the government offers crop insurance, there are many farmers who go to private insurance companies. Private crop insurance companies are a lot easier to work with. Also, they are more flexible and easier to keep in contact with, which is why farmers in Stoughton use private insurance companies.

In order to receive crop insurance farmers have to plant crops after the 14th of April, Farmer #1 planted their corn on May 20th, in order to receive the insurance benefits. Crop insurance can be calculated two different ways actual yield vs. the average then split the difference across all fields. Otherwise, crop insurance is calculated by finding the average per field and split that average among other fields. If there is no average for the fields then an average for the county will be used. This county average equals either less or more than the

actual average of their fields. Farmer #2 and all other farmers go through this their first time receiving crop insurance. Even with crop insurance the farmer will not receive the same compensation as the farmer would during a normal year. Another disadvantage using crop insurance is the adjuster. The adjuster will go and assess the crops and the damage done by the drought. It is all in the adjuster's hands when it comes to crop insurance.

The Agricultural Adjustment Act or the AAA was part of the New Deal. This act restricted agricultural production by paying farmer subsidies not to plant part of their land and let fields lie fallow and to kill off livestock (Lotterman, 1996). This act was supposed to provide a raise in the value of crops and reduce crop surplus. This was deemed unconstitutional in 1936, and in 1938 a revised act was produced emphasizing soil conservation, maintaining balanced prices, and establishing food reserves for periods of shortages (Lotterman 1996: 4-14). Years later the Commodity Credit Corporation or CCC was created. This program is government-owned and operated entity that was created to stabilize, support, and protect farm income and prices (Whittaker 1990: 1-12). This program was supposed to cause net income decreases in the drought region and increases in the non-drought region causing differences in farming income. This was implemented after the 1988 drought since there were many differences between the incomes of drought and non-drought states. The government keeps creating and abolishing programs in order to help farmers, even though some think the government is too involved.

6. Survey Results

Surveys were distributed at the Dane County Farmers' Market. A total of sixteen completed surveys were collected. The stands did not want to have their pictures taken except for one (Image 1). The picture is of their stand, but they insisted that they would not be included

in the photo. The vendors did not include signs saying where they were from. Only one other vendor who included their name and they were from a farm called Small Family Farm. Survey questions are located at Appendix 3.

When asked what types of crops were grown (Question 1): 13/16 answered Root Vegetables, 13/16 answered Leafy Vegetables, 13/16 answered Fruit Vegetables, 10/16 answered Stalk Vegetables, 13/16 answered Tuber Vegetables, 14/16 answered Bulb Vegetables, 5/16 answered Legumes, and 0/16 answered Other (Chart 1).

When asked how many different types of crops were grown throughout the year (Question 2): 3/16 answered 1-10, 5/16 answered 11-20, 3/16 answered 21-30, and 5/16 answered 31 or more (Chart 2).

When asked where does the water for your crops come from during a drought year (Question 3): 13/16 answered Rainfall, 3/16 answered Surface Water Irrigation, 9/16 answered Ground Water Irrigation, 3/16 answered Water Storage Tanks, and 0/16 answered Other (Chart 3).

When asked where does the water for your crops come from during a non-drought year (Question 4): 14/16 answered Rainfall, 1/16 answered Surface Water Irrigation, 6/16 answered Ground Water Irrigation, 3/16 answered Water Storage Tanks, and 1/16 answered Other with writing in personally watering as the answer (Chart 3).

When asked what kind of strategies did you use to cope with the 2012 drought (Question 5): 7/16 answered Replant Vegetables, 2/16 answered Replant Drought-Resistant Vegetables, 1/16 answered Harvest and Provide Drought Resistant Wild Plants, 15/16 answered Additional Watering, 8/16 answered Mulch Planting Surfaces, 5/16 answered Expand or Enhance Irrigation Infrastructure, 0/16 answered Participate in a Regional Produce Exchange Network, and 1/16

answered Other with writing in "preparation" as their answer (Chart 4).

When asked should the government develop relief programs to assist small-scale farmers following a drought (Question 6): 8/16 answered Yes and 8/16 answered No. The answers for Yes included: To save money/time and it would help local farmers a lot, check to make sure crops people have fresh/good products, because other farmers may not have their own water (sources) from rivers to provide for their gardens, we matter too, and because they're doing so much to help large corn and bean farmers, they should help the small farmers too who are actually growing food. The answers for No included: Too much government isn't good, less intervention would be better for everyone, the feds don't need to be more involved with families, no funding – shut it all down, and we can't afford to give any more handouts.

Small-scale producers seem to grow a variety of crops compared to the farmers interviewed. Also, the farmers interviewed had livestock where the participants taking the survey did not. These smaller producers had a larger variety of watering practices than the people conducting the participants in the interview. Also, between the small producers, who took the survey, additional watering techniques were used during years of drought than years of non-drought. Lastly, the small producers would try other cooping exercises during times of drought compared to the two producers being interviewed. In conclusion, the small producers use many more strategies in order to help their crops grow because of the small amount of crops these producers have to make money off of.

7. Archival Research

7.1 Aerial Photograph Interpretation

Aerial photographs from the Arthur Robinson Map Library document different years throughout the past century. Aerial photographs are not taken every year. The first of the aerial photographs were taken on June 24th, 1937 for Stoughton, WI. At this time, the Palmer Drought Severity Index was at about -3.0, which is considered a severe drought (Chart 5). From 1930 to 1937 droughts were more severe. The cumulative drought effects from the 1930s can be seen in the 1937 aerial photograph (Image 2). The aerial photographs that are available for the 1980s include August 19th 1987. During this time, the Palmer Drought Severity Index was also about -3.0 (Chart 6). The major drought during this decade happened in 1988 and 1989. By looking at 1987 photograph (Image 3), the start of a drought period is shown. In the 1937 photograph, the later stages of a drought period are shown. The last aerial photograph was taken on April 13th, 1995 (Image 4), which was not a drought year (Chart 7). By comparing all of the three photographs together, views of the landscape are shown during drought and non-drought years using the repeat photography method.

Combining all of the Palmer Drought Severity Index values together on one graph makes it much easier to see all of our years in focus on one graphic (Chart 8). The most severe year of drought in the 1930s was 1934. The Palmer Drought Severity Index is cumulative, meaning that the months before have an effect on the current month's value. In the 1930s, the major droughts started in 1932, which is why there is a significantly lower value for 1934 than 1988 and 2012. 1988 and 2012 are close in their comparison. It is still hard to interpret the results from the 2012 drought because it is still occurring today.

When looking at all three of the aerial photographs, the main feature that runs from north to south is the Yahara River. In the 1937 photograph, the river is shown at its lowest level. By comparing photographs from 1987 and 1995, the 1985 photograph has less water coverage and

there are parts of land that show through that look like islands along the river. Toward the south side of the image, the river turns white. This indicates that there is no water and only soil where the river flows. In the 1987 photograph, the Yahara River is lower when comparing it to the 1995 photograph, but not as low as the 1937 photograph. By looking at the river, it shows how the drought was more severe in 1930s compared to the other years.

In the 1995 photograph, there are more areas of cropland that are shown as square and rectangular fields in the photo. Towards the northern part of the photo near the Yahara River, there appears to be the most growth in croplands when comparing it to Image 2 and Image 3. In Image 2, the fields appear to be the lightest in color. This signifies that there is open soil and bare fields, rather than vegetation. This could be because of the drought, or it could just be part of the cycle of field plowing and planting.

Other features of the photos that show the change through time include the growth of the city of Stoughton. When comparing Image 2 with Image 4, the main concentration of growth is in the northwest corner of the photos. This growth could be because of the expansion of farmlands to the north. This could also be because the city of Madison is located north of Stoughton, so growth would tend to be concentrated towards the larger city. The expansion of roads in Stoughton is shown throughout all of the photos. In Image 2, there are mainly just roads branching out from the main street that runs from west to east across the photo. When comparing Image 2 to Image 3, there are more county roads that were added to the cropland areas, which indicates that there may have been a demand for easier access to the farms. This could also imply that after the 1930s, the tractor became more common throughout the landscape for farming practices. There is also an expansion of roads in the northwest corner of the photos. The roads there are more curved when comparing them to Image 2s road layout and they appear

to have small houses along the roads. This indicates the expansion of suburbs from the city that was common in the 1950s. Also, looking at the roads in Image 2, they appear to have a high reflectance when compared to the other two photos. This may indicate that some of the roads were unpaved in 1937.

7.2 Comparing Photographs

Water had a huge impact on life. Dams are created to control water flow and produce energy, but the dam in Stoughton, Wisconsin, just controls water flow or retains water. The dam is located on the Yahara River that runs right through town. Dams have been present in Stoughton, Wisconsin, for over a hundred years, as it was one of the first projects constructed by Luke Stoughton. This dam was called the Mill Dam (Image 5). The dams that are standing on the Yahara River might not be standing too much longer as there is talk about safety and flooding relating to the dams (Johnson 2009: 1-4). Dams have huge impacts on water and land. These dams can affect the farmers and their farmland nearby.

The picture of present day dam in Stoughton, WI is shown at Image 6. This dam helps with the flow of the river even though it is not a very large dam. The removal of the dam may cause more erosion, easier flooding tendencies, affect the surrounding wetlands, and decrease water quality due to run-off (Johnson 2009: 1-4). This can greatly affect farmers land and areas that surround the water. Since the climate is changing there is a possibility that allows for more severe weather events. The amount of precipitation will stay the same, but there will be lesser days of rainfall, which causes higher amounts of rainfall in a day. With the lesser days of rainfall drought will be more severe. This will end up causing more erosion and run-off during days of

rain; which will end up affecting the farmer's land and crops.

7.3 Plat Book and Land Ownership Change

During the nineteen thirties, countless families up and abandoned their homesteads to seek refuge in the west. These folk are commonly known as Okies, due to the fact that the Dust Bowl was at its worst in the Oklahoma area, but many Wisconsinites were displaced as well. We thought it would be interesting to compare how droughts in recent years affect farms with regard to ownership and landscape change. Are folks still being displaced, or have current practices stabilized farming? This would help us to understand how severely droughts affect farm finances over the years as well as how far farming practices have come since the days of the nineteen thirties.

We gathered various Plat Book maps for the Stoughton area of WI. Plat books are maps created on a county level and represent the farms in the area with regard to shape, size, and ownership. By comparing changes in ownership and shape change in the years immediately after a major drought to several years without any major drought, we can see whether or not that drought had any major impacts. Thus, we found plat book images for the Stoughton area in 1988 (Map 2) and 1991 (Map 3). With these we can see changes in farm ownership following the 1987/88 drought. We then found plat book images for the same area for the years 2005 (Map 4) and 2007 (Map 5). During this time there was no major drought and thus we will use the changes between these years as a control.

Once we found the Plat Book images of the Stoughton area for the years we wanted to compare, we began to mark the changes we could see. In Map 2 and Map 3, you can see the Plat Book images for 1988 and 1991. Any land parcels that remained under the same ownership is

either unmarked or circled in blue. The red markings represent any changes in ownership or farm size. Map 3 and Map 4 shows the changes between 2005 and 2007.

Between the years of 2005 and 2007 we only counted 4 changes in land ownership. This was to be expected, as theses were non-drought years. Yet, between 1988 and 1991, we only counted 8 changes in land ownership. This may be double the change found in non-drought years, but we do not think it is significant enough to make any claims about the drought's effect on the area.

Previously, in background and historical research on the 1988 drought, we found a report by Gerald Whittaker about the financial impacts of the drought in the states affected most (this includes Wisconsin). The findings of this report state that the financial losses during the drought were minimal. By taking advantage of higher commodity prices, insurance payouts, and CCC loans, farmers at this time were able to maintain a stable income. Furthermore, the people we interviewed as a group explained the farming practices used to combat the drought. By adding nutrients to the soil, low tillage, and drought resistant hybrid crops, the effects of the drought are much less significant than in past years. They also mentioned the fact that prices for crops often rise during drought years because they are often bought and sold in the market before harvest.

8. Conclusions

Through our research, one of the most important finding was the current farming practices, market structures, and policies on drought have stabilized the industry to the point where farmers in the area feel safe on a long term basis. Farming practices such as low till plowing, adding nutrients to enrich the soils, and personal knowledge of the area from generations of experience do much to lessen the effects of the drought. This is unlike the days in

the 1930s when practices such as deeper plowing only proved to exacerbate the effects of the drought. The farming market of Southern Wisconsin has also come a long way since the days of the price collapse in the 1930s. Buyers and sellers anticipate and prepare for future events more so than the past. Crops are bought and sold from mid and large scale farms long before the harvest yield is actually known. Farmers know beforehand how much of each crop is needed in the marked and thus are less likely to flood the marked with unwanted goods. A more future oriented mindset in the market maintains stable prices throughout the year and even drive up prices during events such as drought. The spike in crop prices during drought years makes up for any losses in yield.

The government and private farm insurers provide the necessary aid to farmers in times of need. Larger government organizations provide relief to the mid to large-scale farmers on a national level. Smaller scale farmers prefer to use local companies and insurers who understand the area better and can be more flexible and personal with coverage and help. In total, there are plenty of places for farmers to seek aid in Wisconsin and each farmer has freedom to choose which method is best suited for their farm.

Yet, there is still much uncertainty in the Wisconsin farming industry as we progress into the 21st century. In 2008, the Farm Bill was renewed with a budget of 300 billion dollars. In 2009 the nation went into a recession and people in all industries across the country experienced the financial crisis. The budget for the 2008 Farm Bill was criticized for being excessively costly and added to the deficit in the economy. Thus, there has been a much stronger debate as to whether a 2012 Farm Bill should or should not be passed. Ideas are changing as to how crisis in the farming industry should be met when the country as a whole does not have the money to funnel into the problem of a single industry. Of the producers we surveyed over the course of

our research, half of them felt the more government spending and intervention would be useful while the other half felt they would be better off with less government in their lives. We expect to see heated debates about the farming industry of Wisconsin in throughout the next few years.

9. Future Research

Limitations of just having one semester to conduct this project led us to believe that future research on our research question could allow for more conclusions. More time would allow us to distribute more surveys over a wider area. Having more time in during the summer months would have allowed us to get a better viewpoint from the farmers when the drought was starting in 2012. Also, with more time, we would be able to conduct more interviews with farmers not only just in Stoughton, WI, but also all across southern WI.

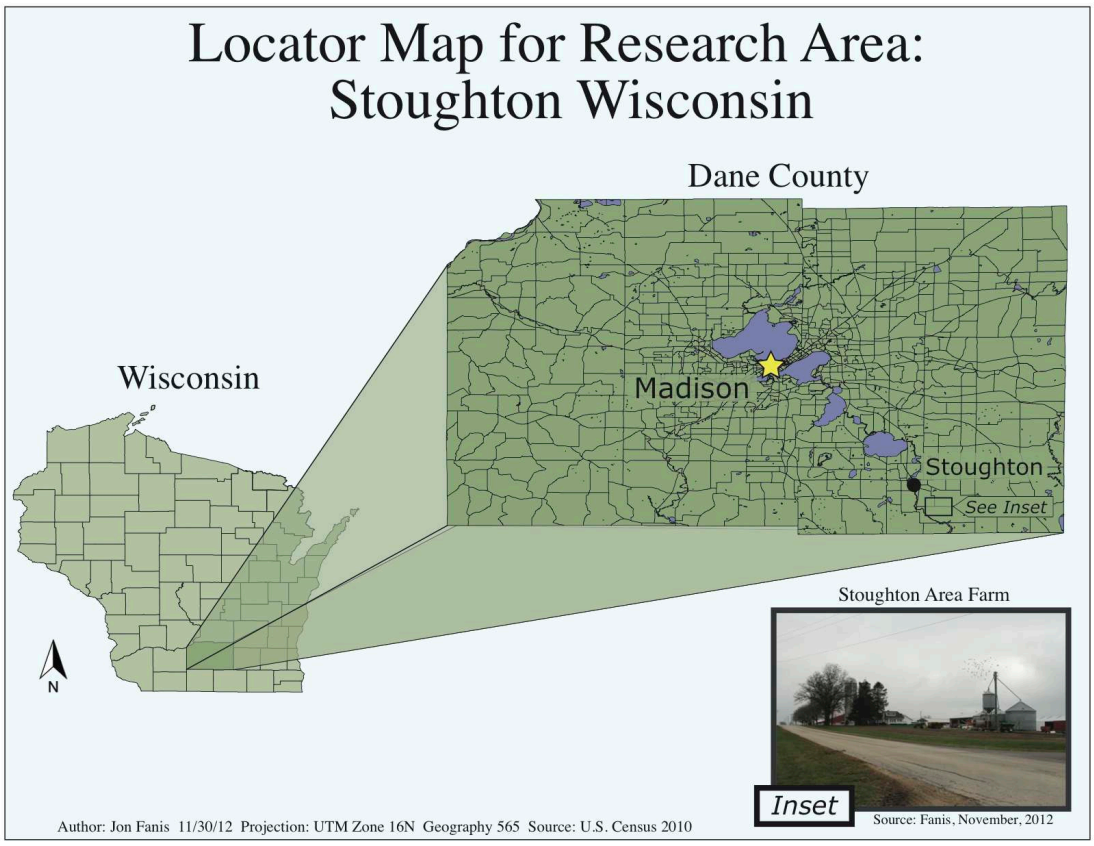
Looking into different types of aerial photographs would have been easier to do with more time also. Soil maps of the area, but different kinds of satellite imagery, would have allowed us to see vegetation changes over times in and out of drought. This is also a limitation of not having any funding for our research. With more time and equipment, a full analysis of the Universal Soil Loss Equation would have been able to do over our research area.

In the future, more research could be done in looking for archival sources. Land ownership maps from the 1930s would also be interesting to find because of the more severe drought conditions throughout the 1930s. With this, we would also be able to see how many people left Wisconsin and not just the Great Plains during the Dust Bowl. Future examination of archival photographs would also allow us to see the conditions of the droughts from the past. Conclusions could also be made by finding records, diaries, and other first hand accounts of times during drought.

Looking at other indexes besides the Palmer Drought Severity Index would also be useful in the future. This would help analyze the weather conditions in both the short and long term. Also, researching other droughts in the past besides the 1930s and 1980s would help in comparing the current drought of 2012's severity. There are many ways in which drought and agriculture can be researched. Only having one semester to find answers to our research questions gave us valuable conclusion, but it also limits our research and leaves us with more questions.

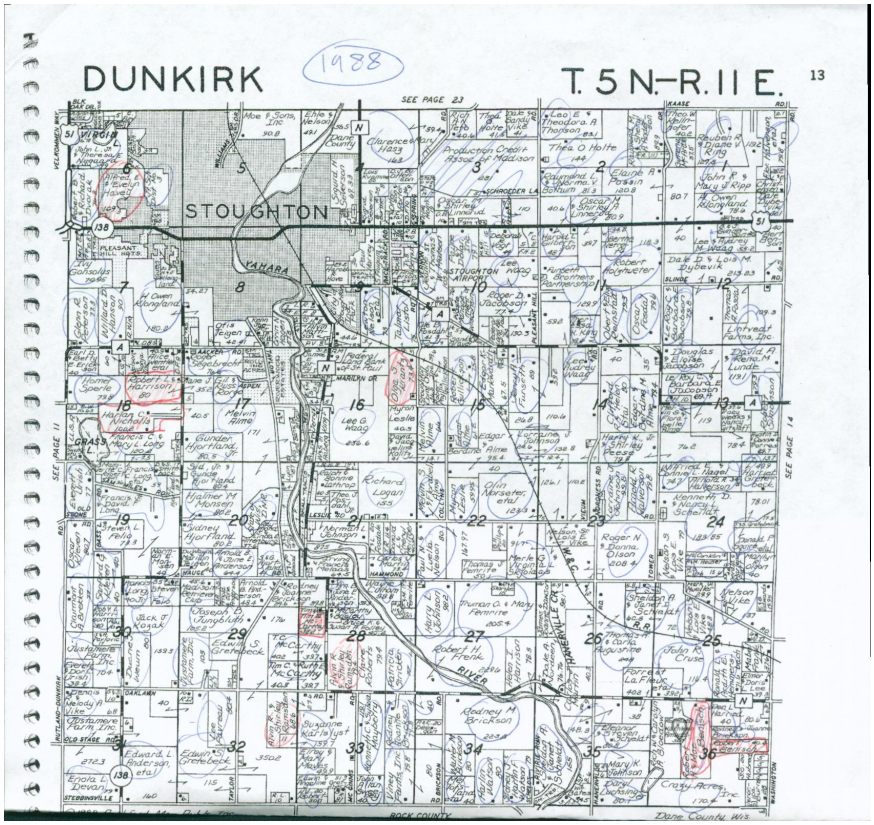
10. Maps

Map 1: Locator Map for Research Area



(Fanis, December 2012)

Map 2: Plat Book Map from 1988

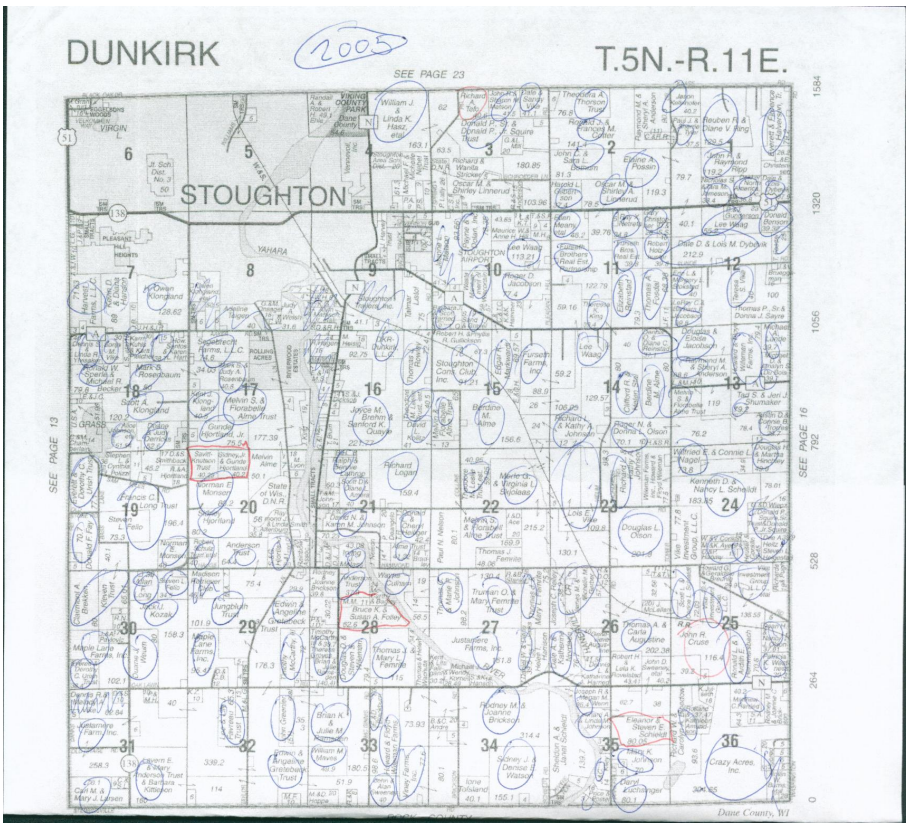


(1987) Land Atlas & Plat Book: Dane County, Wisconsin (1988). [Dane County, WI]

Map 3: Plat Book Map from 1991

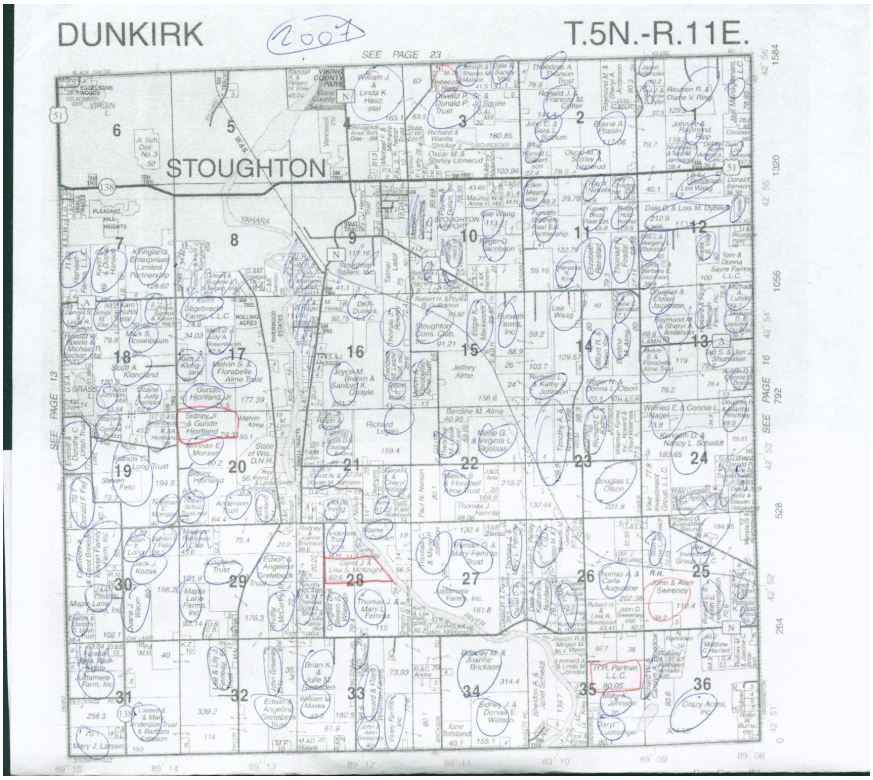
(1990) Land Atlas & Plat Book: Dane County, Wisconsin (1991). [Dane County, WI]

Map 4: Plat Book Map from 2005



(2004) Land Atlas & Plat Book: Dane County, Wisconsin (2005). [Dane County, WI]

Map 5: Plat Book Map in 2007



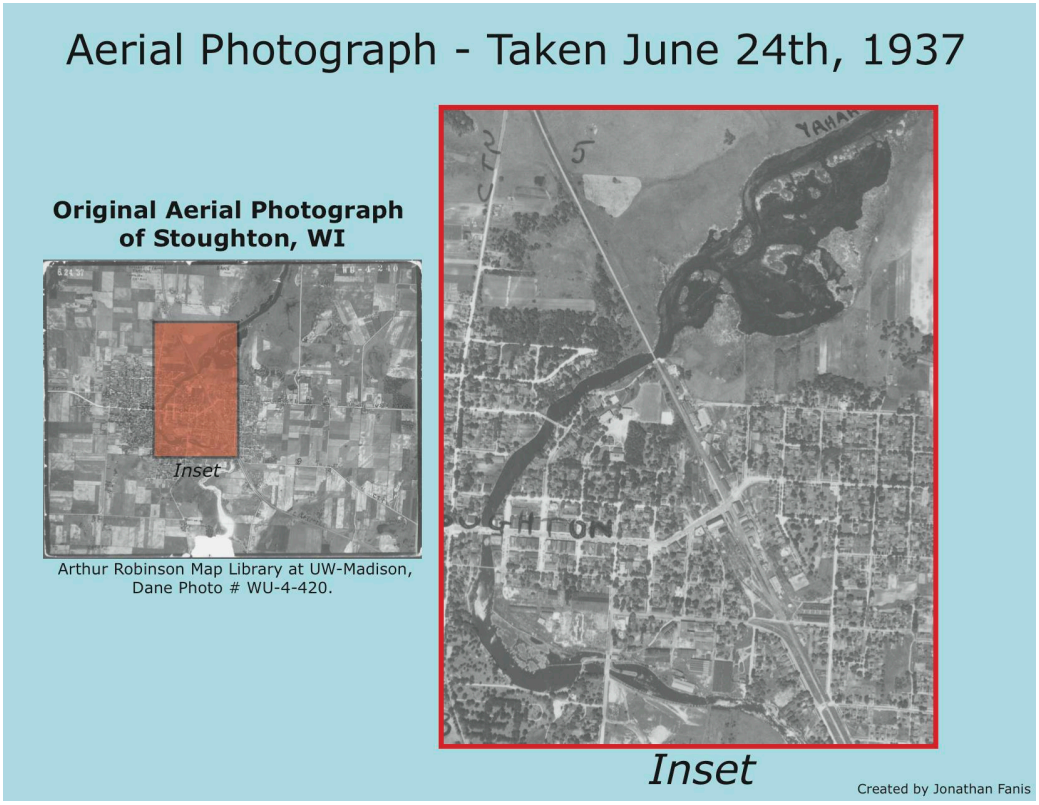
(2006) Land Atlas & Plat Book: Dane County, Wisconsin (2007). [Dane County, WI]

11. Images

Image 1: Singing Farm Gardens stand at the Dane Co. Farmer's Market

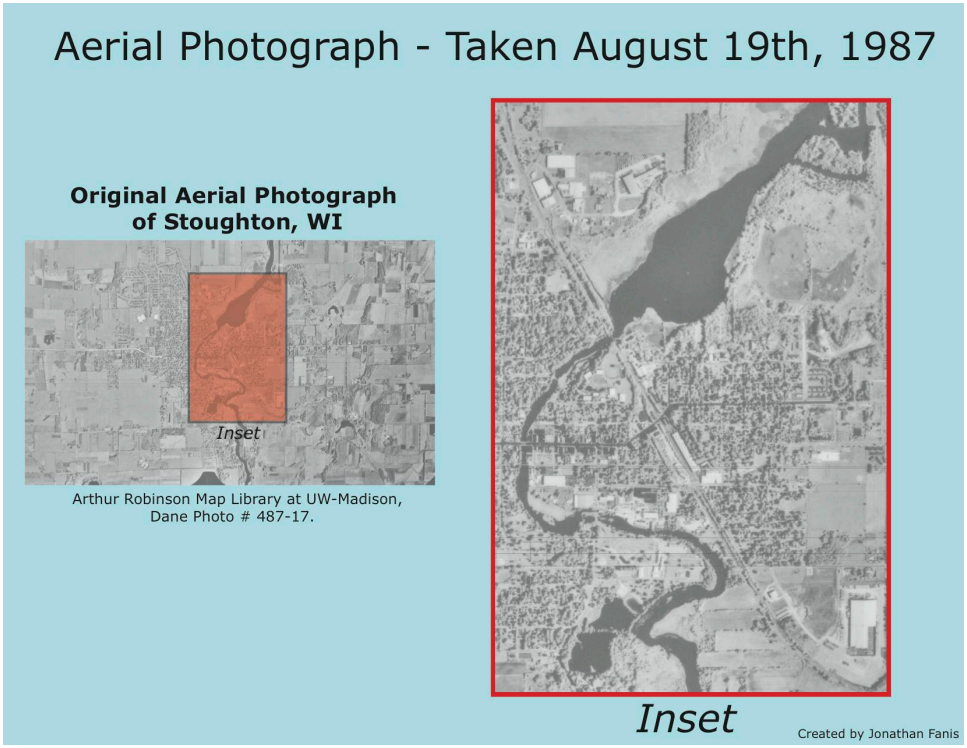
(Fanis, November 2012)

Image 2: Aerial Photograph from 1937



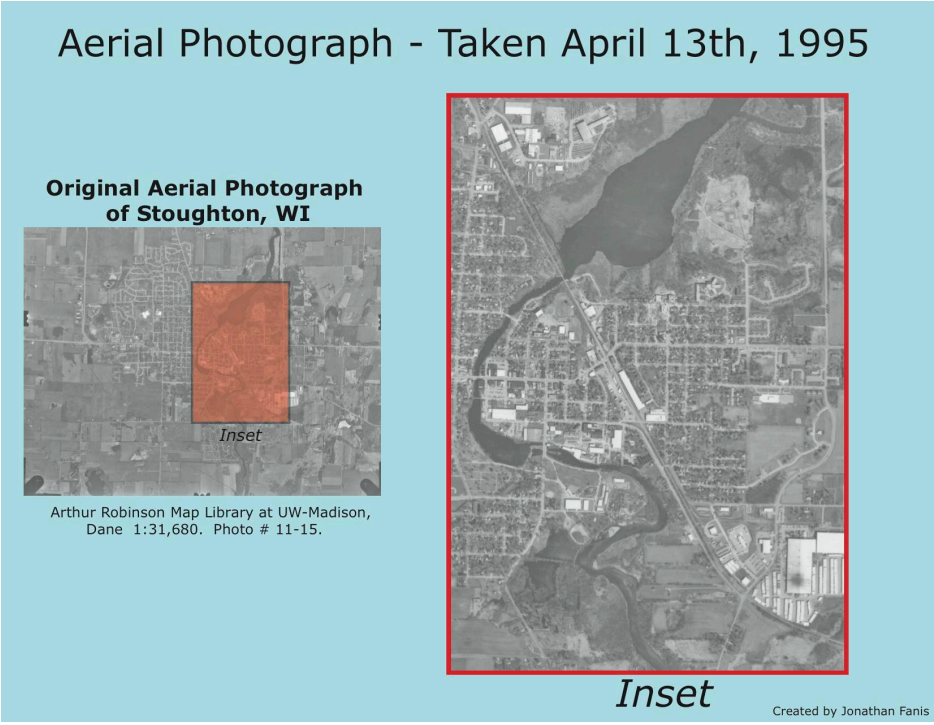
(Fanis, December 2012)

Image 3: Aerial Photograph from 1987



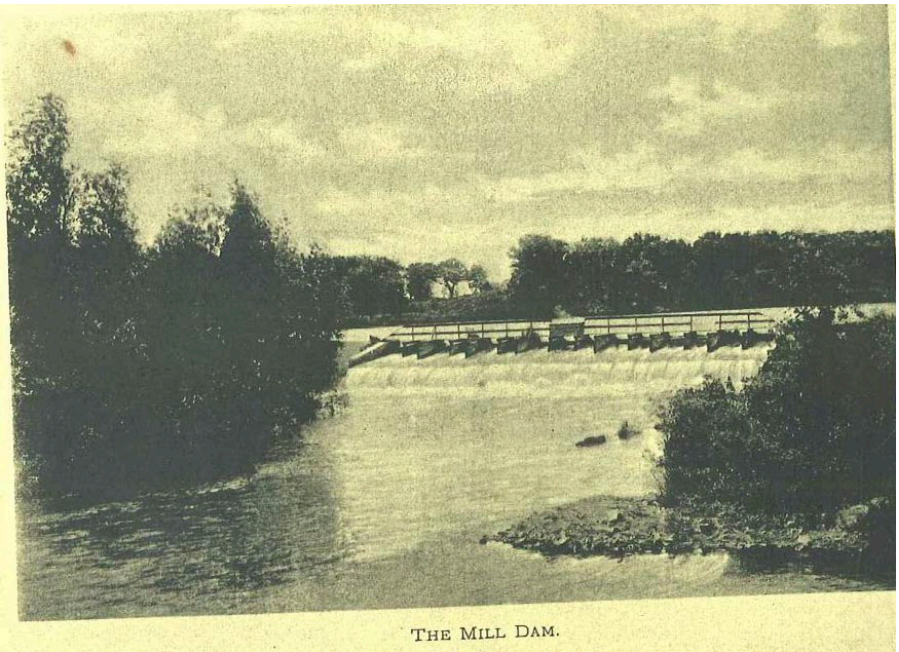
(Fanis, December 2012)

Image 4: Aerial Photograph from 1995



(Fanis, December 2012)

Image 5: The Mill Dam



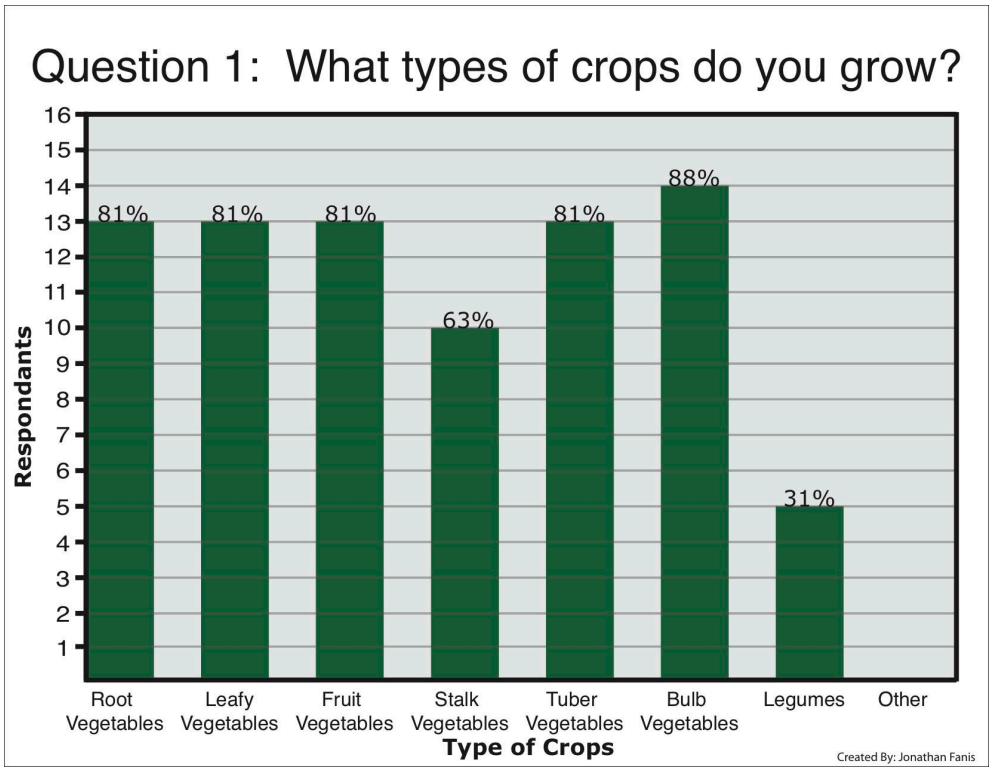
Souvenir of Stoughton, WI & Lake Kegnosa, 1908 Call #: PH6475 Archives Visual Materials Holdings

Image 6: Dam in Stoughton, WI

(Fanis, November 2012)

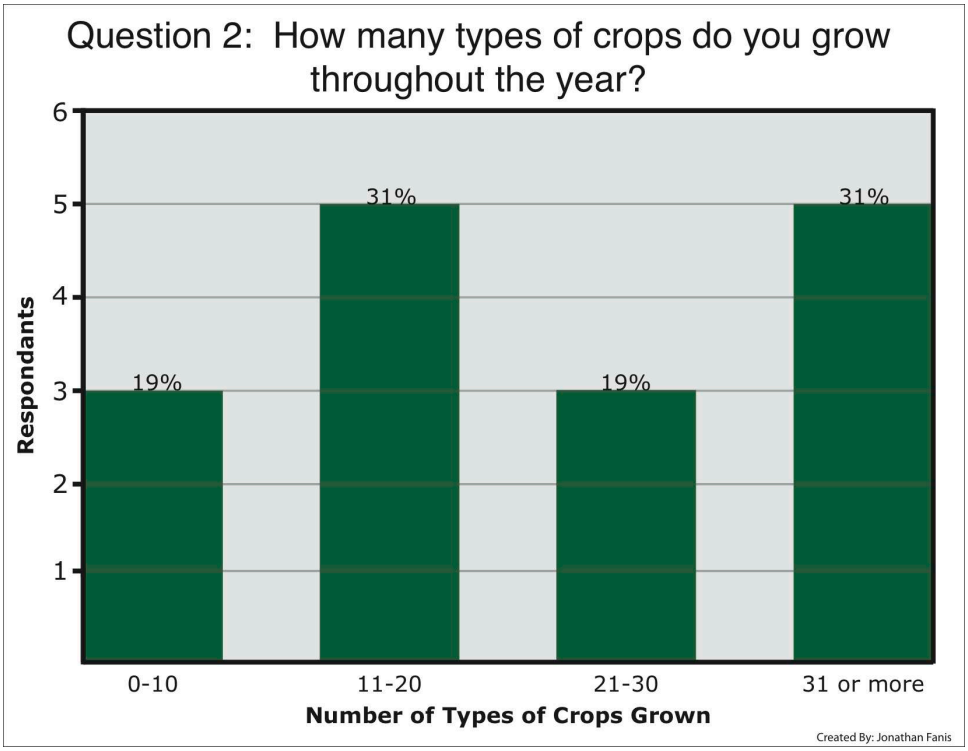
12. Charts

Chart 1: Survey Question 1



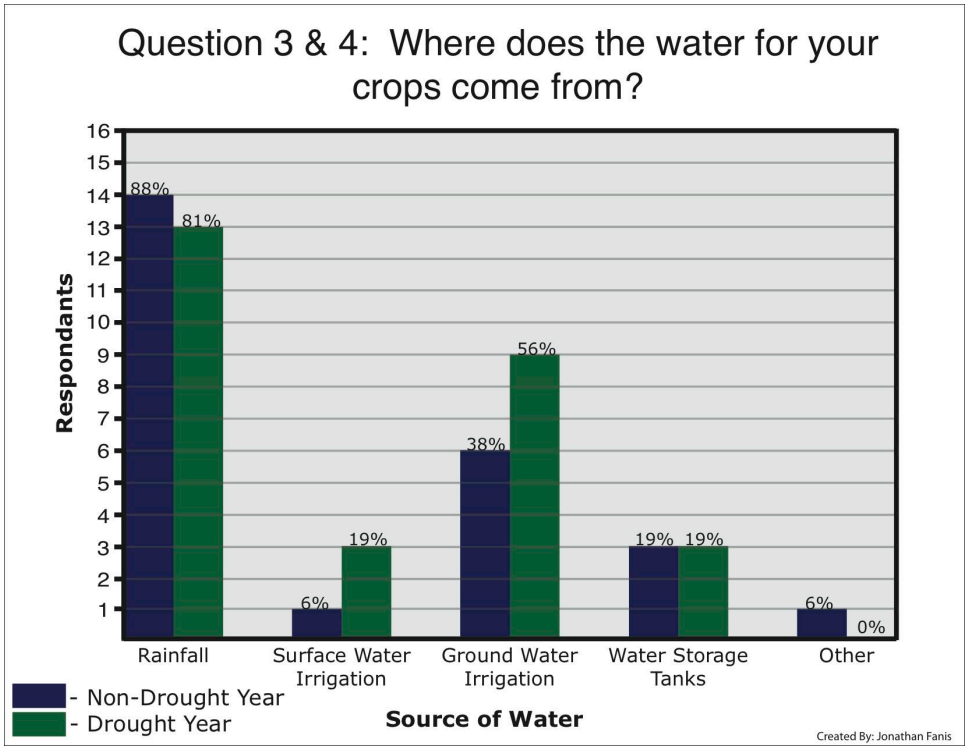
(Fanis, December 2012)

Chart 2: Survey Question 2



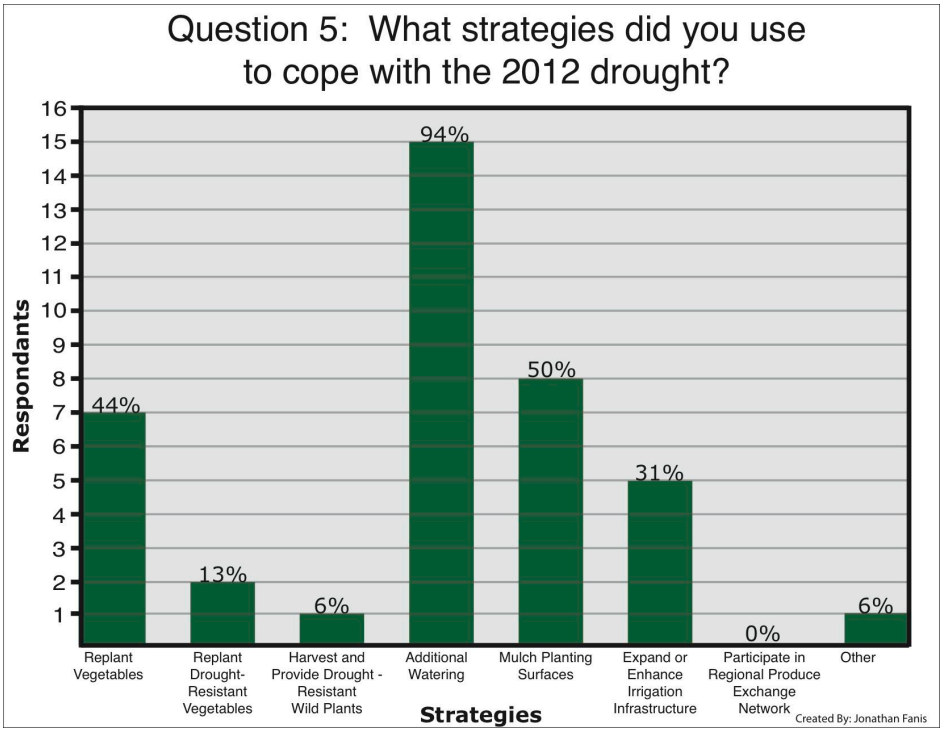
(Fanis, December 2012)

Chart 3: Survey Questions 3 and 4



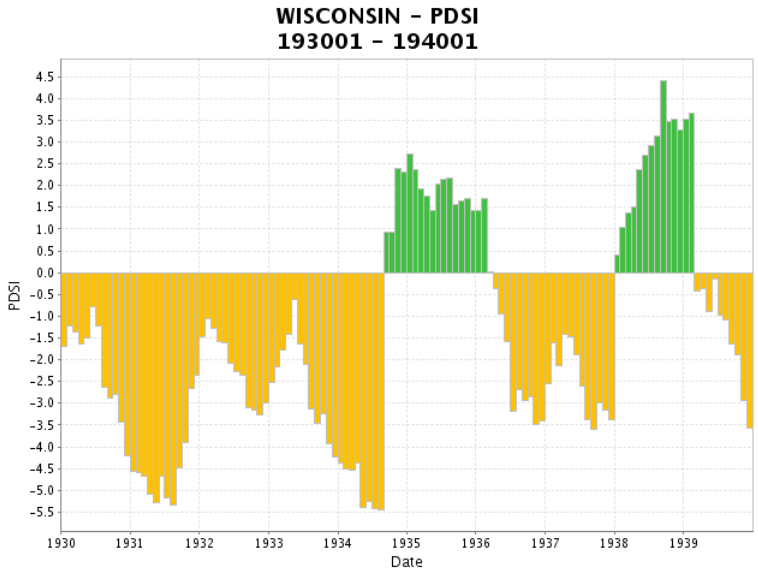
(Fanis, December 2012)

Chart 4: Survey Question 5



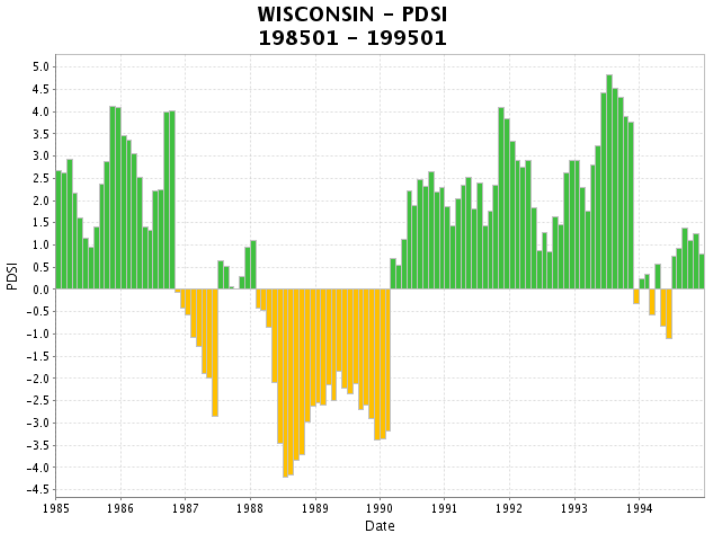
(Fanis, December 2012)

Chart 5: Palmer Drought Severity Index from 1930 to 1940



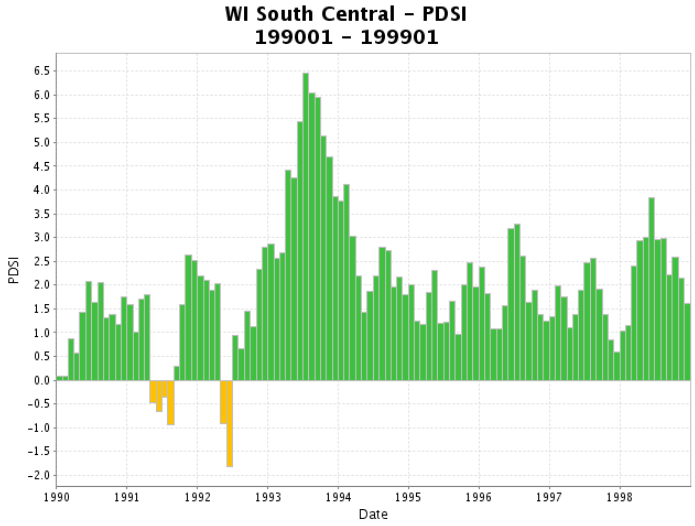
(http://www7.ncdc.noaa.gov/CDO/CDODivisionalSelect.jsp#)

Chart 6: Palmer Drought Severity Index from 1985 through 1995



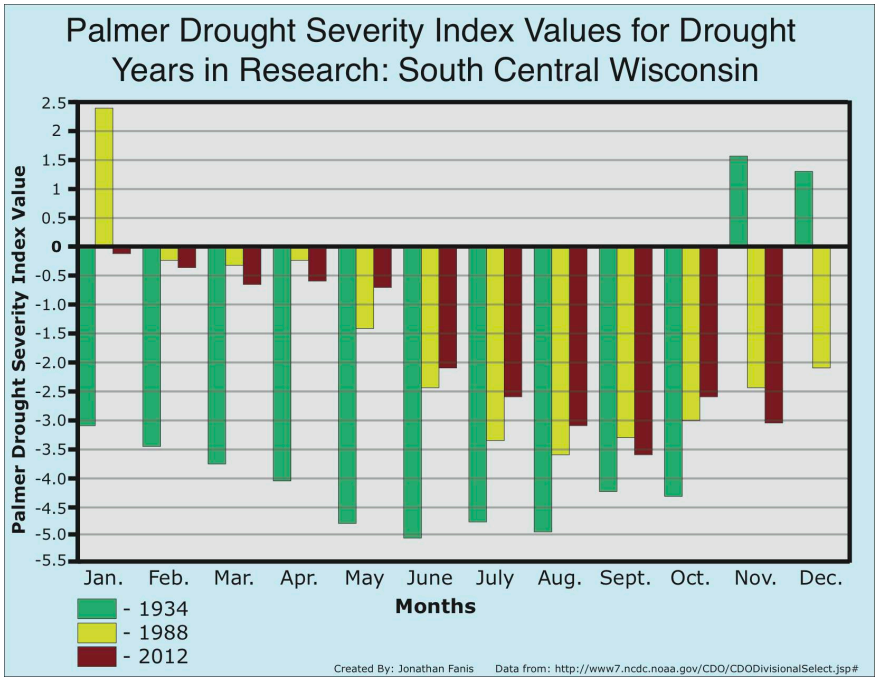
(http://www7.ncdc.noaa.gov/CDO/CDODivisionalSelect.jsp#)

Chart 7: Palmer Drought Severity Index from 1990 through 1999



(http://www7.ncdc.noaa.gov/CDO/CDODivisionalSelect.jsp#)

Chart 8: Combined Palmer Drought Severity Index for Research Years



(Fanis, December 2012)

13. Appendix

Appendix 1: Confidentiality Agreement

Shasta Vercauteren
Jon Fanis
Michael O'Hare

Privacy Policy

We are geography students at UW-Madison conducting an interview for a research project concerning the impacts of drought on agriculture. Your privacy is important to us. Please know that the information collected will be used solely for this project. We will not record or report any personal identifying information about you without your permission. If you wish, we can assign you an alias in our report (eg Farmer One). All questions are optional. Our final paper will be digitally archived at UW-Madison. We are happy to provide you with a digital copy. You are welcome to attend a public presentation of our project on December 14th 2012 at Science Hall on the UW campus. Please contact us at jfanis2@gmail.com, svercauteren@wisc.edu, and mohare@wisc.edu with any questions about our research.

Appendix 2: Interview Questions

Interview Questions

1. What kind of crops do you grow throughout the year?

2. How has the 2012 drought compared to earlier droughts?

3. How did the 2012 drought affect your farming practices?

4. How much crop loss did you have during the 2012 drought?

5. What water resources do you use on your farm?

6. Do you have to go to other water resources during a drought?

7. Have market prices exacerbated the effects of the 2012 drought?

8. Do you feel the government needs to help farmers more in times of drought?

9. What types of government drought relief options are available to your farm?

10. If so, which programs have you applied for?

11. How efficient has the government been during this process?

12. Is it beneficial to have insurance when comparing the insurance refund to the loss?

Appendix 3: Survey Questions

1. What kind of crops do you grow? (Check all that apply)
   - ☐ Root Vegetables (Beets, Carrots, etc.…)
   - ☐ Leafy Vegetables (Spinach, Lettuce, etc.…)
   - ☐ Fruit Vegetables (Peppers, Tomatoes, Eggplants, etc.…)
   - ☐ Stalk Vegetables (Celery, Asparagus, etc.…)
   - ☐ Tuber Vegetables (Potato, Yam, etc.…)
   - ☐ Bulb Vegetables (Onion, Garlic, etc.…)
   - ☐ Legumes
   - ☐ Other _____
2. How many different types of crops do you grow throughout the year?
   - ☐ 1-10
   - ☐ 11-20
   - ☐ 21-30
   - ☐ 31 or more
3. Where does the water for your crops come from during a drought year? (Check all that apply)
   - ☐ Rainfall
   - ☐ Surface Water Irrigation
   - ☐ Ground Water Irrigation
   - ☐ Water Storage Tanks
   - ☐ Other _____

4. Where does the water for your crops come from during a non-drought year? (Check all that apply)

- ☐ Rainfall
- ☐ Surface Water Irrigation
- ☐ Ground Water Irrigation
- ☐ Water Storage Tanks
- ☐ Other _____

5. What strategies did you use to cope with the 2012 drought? (Check all that apply)

- ☐ Replant Vegetables
- ☐ Replant Drought-Resistant Vegetables
- ☐ Harvest and Provide Drought Resistant Wild Plants (Purslane, Burdock, etc….)
- ☐ Additional Watering
- ☐ Mulch Planting Surfaces
- ☐ Expand or Enhance Irrigation Infrastructure
- ☐ Participate in a Regional Produce Exchange Network
- ☐ Other _____

6. Should the government develop relief programs to assist small – scale farmers following a drought?

- ☐ Yes
- ☐ No

- Why?

14. Bibliography

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